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EDITORIAL

The Storage of Fruit

THE Hurter Memorial Lectures have invariably been of interest, but few have been so interesting and useful as that given by Sir William Hardy, F.R.S., on "Some Recent Developments in Low-temperature Research." The financial situation of this country and the tariff and other barriers that restrict international trade combine to force us here to pay greater attention than we did to the storage and preservation of our own produce, and the particular produce discussed by Sir William Hardy is the familiar English apple. Most of us know or believe that the best English apples are the best in the world: they are expensive it is true unless you grow them yourself. In that case they may be either very expensive or very cheap, but few of us record our garden experiences on lines that would be approved by a chartered accountant, nor is the exact value of the time we spend in the garden easily calculated. We feel sure that there are many facts disclosed in this Hurter Memorial Lecture that are new to the majority of our readers, familiar as they may be to the members of the Food Group. For instance, we have all known from our childhood that the living plant imports carbon dioxide and exports oxygen; it is not so well known that the apple fruit takes in oxygen and exhales carbon dioxide. Presumably it does this while it is still attached to the tree and it certainly does this after it has been detached and is still alive. The death of a portion of a plant is not necessarily a fixed point of time. You may cut off a cutting that will live and put forth roots and rival the original. The tree grows an apple and though the edible part may perish or be devoured the pips may live and we fancy that if someone took trouble enough he could find an infinity of gradations between the fission of a diatom, the grafting of roses, and the separation of the pip, so that it would be hard to lay down a definite rule and say what is an individual plant and exactly when it dies. Many of us did not know that the terminal apple of an inflorescence is quite different from the rest and has different chemical characters; we wonder whether the grubs that prey on apples are aware of these differences. In any case, such apples, "king apples" as they are called, must be rejected from chemical research as being abnormal. Many of us did not know that apples give off vapours or emanations in minute quantity, which are profoundly poisonous to other fruit but very helpful in speeding up the ripening of young apples, so that a colony of apples tends to ripen at the same time. These facts and many others and much sage explanation will be found in this lecture and we are glad to publish it in our JOURNAL this week and to express our gratitude to Sir William Hardy for a contribution that all may enjoy and some can turn to a moral or other profit.

Publication of Chemical Research

Every new fact in chemistry is of some interest, even if only to its discoverer, and new facts, and in some cases new theories, may be of outstanding interest and importance. There are observations that appear at once to be trivial, others are obviously of importance and there is a huge intermediate class the classification of which can only be carried out by the expert. The prompt publication of valuable new matter whether scientific or technical is of the utmost importance to the science and the industry and is the cause and almost the only cause of the formation of most of our chemical and allied societies. This prompt publication of transactions and their logical outcome abstracts is essential to every chemist engaged in teaching or in industry; without these he could not earn his income and he should regard a subscription towards the cost of publishing these essentials as a first charge on his income and an outward and visible sign of his gratitude. There are two considerations that interfere with this exhibition of gratitude, one is that the junior chemists often find the payment of a few guineas to be inconvenient, the other is that many of the senior chemists require so many transactions and so many abstracts that the expense of these becomes almost equally intolerable. Nevertheless, the transactions and abstracts must

be published and must be paid for and it has been found that a very useful contribution to the expense can be obtained from advertisers, usually in our case engaged in the manufacture of chemicals or chemical plant. These two industries could of course if they thought fit make a grant in aid of such publication and many such grants have been made in the past both here and in other countries. Those chemists who, as scientific men should, take note of the important facts of a problem as well as the trivial ones should realize that advertisements are not a disagreeable necessity, but a very welcome form of assistance for which the publishers of learned matter are very grateful and this gratitude should be and probably is shared by all those who benefit from the publication, that is every chemist. In the case of our own publications we feel sure that our readers do recognize the mutuality that is involved in advertising: the advertiser pays a certain sum and in exchange he receives a measure of publicity. The readers of the JOURNAL can help to make this measure a full one in many ways; they can glance at the advertisements and read those that pertain to their own branch of knowledge, they can call the attention of managers and directors to the existence of special advertisements, they can in some cases use a little judicious influence to help secure further advertisements, and they can, when they buy from our advertisers, mention the fact that their advertisements in our JOURNAL are frequently before their notice. After all if we study the problem carefully we shall come to the conclusion that the advertisements are not intended to benefit only the President and high officers of the Society and the printers of the transactions and abstracts; they are intended to benefit every member of the Society and every reader of the JOURNAL who is not a member. The Society is in reality a kind of wholesale co-operative organization and we are now taking a step that we do not think we have taken before, we are urging our members and others to express their sense of gratitude for our excellent transactions and abstracts not only by paying a subscription out of their own pockets but also by gentle persuasion to assist the good work of extracting revenue from other people's pockets. The more this is done the better will be the chemical literature that we can provide for their instruction.

Osmics

In a story by Mrs. Gaskell of Cranford fame, it is hinted that the power of smelling strawberry leaves is confined to a few of the oldest and most aristocratic families. We chemists must possess a sharp sense of smell to succeed in our laboratories or at least be able to name the constituents of a mixed smell, so that it may be some of us will even be able to detect the odour of strawberry leaves; indeed, Bacon noted a distinct scent of violet in "the excellent cordial smell of strawberry leaves dying." Alas, our further research as often proves this test of aristocracy to be a myth, the scent being confined to the leaves of the wild strawberry, so that if we fail to perceive it in the garden hybrid, we are not necessarily plebian. There is much of interest connected with scent; in homologous series we know it to increase with molecular weight, methane and ethane being odourless, whereas butane has a smell. Methyl and ethyl alcohols are likewise all but odourless, but the smell increases with the higher alcohols. When we approach the art and practice of perfumery, we have to deal with a mixture of substances and with the mental reactions of different human beings to them. Osmics, *i.e.*, the science of smell, has an abundant literature of the moods and memories evoked by odours, and attempts have been made to study odour preferences with some degree of accuracy, notably in the Psychology Department of Edinburgh University. A fascinating subject is that of smell memory, it is so much more vivid than the memories associated with other senses. Whereas a particular scent will recall an incident of the past, it is far more difficult to do the reverse, namely, to conjure up in the memory a particular scent, for example that associated with a clove carnation, though we can form a sharp mental image of the flower. Most of us, perfumers and Dons excepted, have failed to develop the faculty of recalling a scent, perhaps because the opportunity to practise it does not come our way. Scents are provided by the flowers, not for our edification and delight but to guide and attract insects for the purpose of cross-fertilization. The smell of the foliage, stems, and roots of plants is often such as to make herbivorous animals avoid them; sometimes the scent of the flowers and foliage is the same, but more often they differ. There is abundant evidence that insects select or ignore specific scents and even pick out inconspicuous flowers such as the ampelopsis, which to man have no scent. Different flowers give off scent to coincide with the flying time of the insects which visit them, some by day only, as clover, some by night only and others at all times. The adaptations of the flower to its visitors are well known, some of them are remarkable—the aspidistra, whose flowers open flush with the ground, is fertilized by slugs, some cacti look and smell like carrion and attract blow-flies, and most of the flowers fertilized by flies have a disagreeable scent. The bee flowers are honey scented, the moth flowers are fragrant and sweet. In the laboratory we have discovered the natnre of most of the perfumes, and have synthesized not a few of them even on a commercial scale. In the plant there is always a complex mixture, so that it is difficult to imitate exactly the natural by the artificial; apparently the volatile oils are primarily waste products. There is evidence of a design in the mixture of essential oils which produces such a scent as the rose, and round the nucleus of geraniol, or pure rose scent, there are fruit scented, honey scented, and spicey groups, so as to suit all tastes. Such a complexity allows of infinite variation, hence the roses of our gardens. It is of interest perhaps that the yellow roses of all types, which are to-day so fashionable, and the wild yellow roses are devoid of scent or have none of the "old-rose" type of odour, which may well be linked biologically with the colours, white, pink, and red. In the autumn the air smells of damp leaves and scented smoke, whilst of the roses we only have pot pourri for remembrance: it must serve till next June.

SOME RECENT DEVELOPMENTS IN LOW-TEMPERATURE RESEARCH*

By SIR WILLIAM HARDY, F.R.S.

There are two laboratories devoted to research at low temperatures, the Cryological Laboratory at Leyden, and the Low Temperature Research Station at Cambridge. Their aims are distinct though sometimes confused. The former is a physical laboratory where the effect of temperatures some hundreds of degrees below the freezing point upon the physical properties of matter is studied. The Low Temperature Research Station at Cambridge is on the contrary a biological laboratory, where amongst other things the effect of relatively moderate cold upon organisms living or just dead is studied. The range of temperature is from +40° C. to −50° C. and the heavily insulated rooms are so fitted that each can be set at the temperature required and will automatically keep that temperature with an accuracy to be measured in tenths or even hundredths of a degree.

The method of regulation is simple but may be new to those acquainted only with commercial stores. A typical chamber—there are about 30 of them—has pipe grids through which cold calcium chloride brine can be pumped. The first approximation to the required temperature is arrived at in the usual way by regulating the temperature of the brine and the rate of flow through the grids. That however is not enough. There is no method of controlling the influx of cold sufficiently sensitive for accurate research and a second approximation is therefore made by treating the chamber as an electrically controlled thermostat. Each chamber has round the walls a coiled wire through which an electric current can flow. The quantity of heat thus introduced is regulated by a thermometer with a large bulb filled with toluol, the current being cut off or turned on as the temperature rises above or falls below that required. The method is one of differences and can therefore be made as exact as is needed.

Each chamber is indeed a constant temperature laboratory, in which material can be not only stored but also examined microscopically or studied chemically. It is however, a trying experience, as I have myself found, to do accurate microscopic work in 20° to 30° of frost. There, as the monk of Alexandria said, "of sitting as of all carnal pleasures cometh at length satiety!"

The opportunity for advanced biological research is great and that important variant temperature can be studied as it has never been studied before. Biology stands in real need of a knowledge of the effect of temperature, for a large part of biological research has been and is carried out in that vague region called "room temperature." The effect of temperature has indeed been studied in, for example, the chemistry of the proteins of muscle but the measurement of temperature was so loose as to leave a margin of uncertainty of some degrees.

All laboratories have a field of work more or less clearly defined by tradition or by specific relation to some human need. There are laboratories of organic or physical chemistry, of physics and physiology, engineering, pathology, and of agriculture. The field of work of the Low Temperature Research Station is defined by that great need of an urban civilization, the storage and transport of food. The science related to that includes a large part of plant and animal physiology and pathology.

Fruit, when gathered, is alive and since it lives it breathes. By enclosing an apple in a small chamber through which air is passing in a steady stream its rate of breathing can be measured. Pure air is supplied to it, and the outgoing stream passes through a Pettenkofer tube of standardized baryta. The tube is removed at intervals, a fresh one substituted and the quantity of carbon dioxide given off is measured by titration. The result is expressed in milligrams of carbon dioxide per 300 g. of apple. The first figure shows the rate of production of carbonic acid plotted against time. The curve

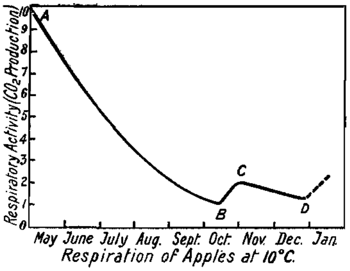


FIG. 1

starts in May, when the flower is fertilized and the apple sets. From May to September inclusive, the apple ripens on the tree, that is it grows, becoming less acid and changing in colour, whilst its seeds come to maturity. Under natural conditions the history should end at B: a wild apple would fall and be eaten and the seeds distributed, for the function of the apple as an organ of the tree is to provide the seeds with cover whilst they are ripening, and to secure their distribution when they are ripe. From B onwards, therefore, the curve relates to artificial conditions known as storage. The period B C D is the storage period, which is of immediate importance in, for example, bringing apples from Australasia or holding them in store at home. It is also the starvation or senescent period when supplies of material from the tree have ceased to come to the apple. A start was made more or less with the idea that the storage period could be studied by itself, but we were quite wrong in this as in many of our earlier ideas. Fruit is as much an organ of the tree as leaves, roots, or stems, and its character therefore depends upon the history and kind of tree it grows upon.

The previous history of *no* biological material can be neglected. Our recent survey of the conditions of transport of New Zealand lamb shows this: the survey

* Hurter Memorial Lecture given before the Liverpool Section of the Society on November 18, 1932.

began on the farm and ended at Smithfield, and what happened at Smithfield was found to depend upon what had happened on the farm perhaps years before. Again, in explanation of the fact that I have started with fruit, it will be appreciated that the prehistory of fruit can be studied relatively easily, by the method of experiment—samples can be obtained in large quantities from different orchards, soils, and climates: it is not possible so to handle cattle, for they cannot be brought to the laboratory in hundreds or even tens for direct experiment, so the method of observation has largely to replace the method of direct experiment and commerce supplies the opportunity for observation.

The work soon resolved itself into an analysis of the variables which affect storage life. About six years ago the following obvious ones seemed enough for fruit: the variety (*e.g.*, Bramley's Seedling, Worcester Pearmain, Cox's Orange Pippin, and so on); the stock on which the tree was grafted: the chemistry of the soil of the orchard; and the size of the apple. To study the effect of, for example, the chemistry of the soil it was then thought enough to take samples of one hundred apples chosen with great care so as to be of the same size, from the same type of tree and of the same variety. Such a small point as the difference of level in the orchard was taken into account—that is to say, the apples of one sample came from trees all of which grew on the same level. In order to measure the effect of the soil, samples chosen in this meticulous way were taken from trees growing on fen land, on silt, and on chalk, and the average duration of storage life of the apples was found to be longer in those grown on silt than in those grown on fen soil. The differences, however, varied so greatly from year to year as to arouse suspicion of the interference of unknown and still uncontrolled variables. This suspicion became so strong as to lead to a comparison of the properties of individual apples from one of these apparently uniform samples. Amongst other things the curves of the output of carbon dioxide were plotted, with the result shown on the slide. In short, the difference between different apples of the sample proved to be greater than the difference looked for and found between different samples.

In the end many new variables were found. For example, the chemistry of an apple and its chemical history were found to depend to a significant degree upon the part of the tree from which it was gathered. One side of a tree, for instance, will get more sun and be on the whole warmer than the other side. That, however, is only a superficial matter; of much deeper significance was the difference between apples from the same inflorescence. The terminal apple is different from the rest and has different chemical characters, and to avoid sampling errors that apple, the "king apple" as it is called, must be rejected. The different variables which shape the senescent period are as follows:

1. Variety (*e.g.*, Bramley's, Cox's)
   Root stock
   Age of tree
   Age of apple on tree (maturity)
   Size of apple
   Position on inflorescence
2. Soil (fen, silt, chalk, *etc.*)
   Manure
   Climate
3. Orchard sanitation.

It is a formidable list and raises formidable difficulties in all research with this kind of complex biological material. It took ten years to disentangle the variables for this one kind of fruit. That will seem a long time but physicists and chemists must recollect that there is only one harvest a year and that each experiment lasts a year.

The study of the prehistory of meat yielded unexpected and interesting results. Meat is the wreckage of living matter. Flesh once was living muscle and at the outset an endeavour was made to trace the passage from the living muscle to the dead flesh. The problem was as large as the study of the nature of living matter itself. The muscles are the organs which move the body. They have the property of shortening in response to a stimulus. The cycle of chemical events which go on in muscle has been analysed in recent years with extraordinary success by physiologists. There seem to be two cycles which may be distinguished as the charging and the firing cycle respectively, and both cycles are due to the orderly sequential activity of groups of enzymes. The two cycles are shown in a schematic way in Fig. 2.

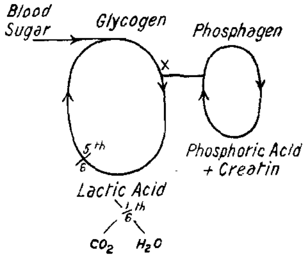


Fig. 2

Changes in the charging cycle are as follows:—(1) From blood sugar to the carbohydrate glycogen which in the muscle has the form of a phosphatic ester. This renews the supply of fuel. (2) From glycogen to lactic acid probably through some hexose phosphatic ester. (3) Oxidation of $\frac{1}{6}$th of the lactic acid to water and carbonic acid. (4) Synthesis of $\frac{5}{6}$ths of the lactic acid back to glycogen. This cycle is continuous: to stop it means death. Of the energy set free in the oxidation of the lactic acid part is used to reform glycogen, part goes as heat, of use to warm-blooded animals, and part to charging the firing cycle.

When muscle contracts the energy comes from a breakdown of phosphagen to phosphoric acid and the nitrogenous substance, creatine. That is the firing cycle.

I need not insist on how incomplete this scheme is. There is nothing in it of processes of repair and growth, or of the synthesis of protein. It is like giving the chemistry of the explosion and neglecting all the other events in the history of a motor-car.

What is the effect of cold upon these complicated catalytic cycles? As such it has little effect. It disturbs the relative rate of working of the different parts it is true, so that there is an accumulation of lactic acid, but on raising the temperature the excess disappears. Muscle can be overcooled to any practicable extent without permanent injury.

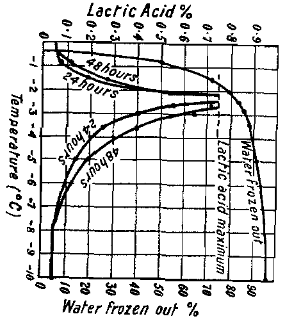


FIG. 3

The freezing point of the particular muscle used was −0·42° C. It was overcooled to −4° C. for some days and returned to normal on thawing. When *frozen* at −4° C. however, it was found to be dead on thawing. It became opaque, shortened, developed high acidity due to lactic acid and the osmotic properties characteristic of the living state were lost. The region 0° to −10° was therefore explored in great detail. Muscles were analysed after 24 or 48 hours' storage in the frozen

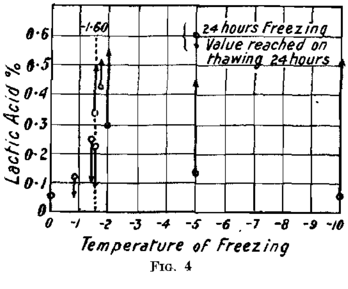


FIG. 4

state and the changes in content of lactic acid, glycogen, phosphorus compounds, etc. noted. With regard to lactic acid, it is remarkable that it is produced and accumulates in the frozen state, the rate of accumulation rising to a peak at about −2° as the curve shows. On thawing the lactic acid either falls to normal or increases. There is indeed a critical temperature at −1·6°, muscles frozen above it retain the power of getting rid of excess lactic acid and reverting to normal and muscles frozen below lose this power. Such muscles are dead on thawing, and the lactic acid increases in them as it does in *rigor mortis*. It is obvious that at −1·6° the catalysts responsible for the synthesis of lactic acid are thrown out of action permanently. The catalysts concerned in the synthesis of phosphagen were permanently lost at −2·5° and those concerned in the oxidation of lactic acid at −3·2°.

Much could be written about this extraordinary story but I can deal here with only one problem—why freezing does what cold alone does not. The answer is that freezing is also drying—water separating as ice. Freezing is a delicate and useful way of drying and all the effects mentioned above are due to drying and can be exactly reproduced by actual drying in a desiccator over solid calcium chloride. When the quantity of water comparable to a given temperature is removed by drying and afterwards restored by soaking in water the effect of drying is exactly similar to freezing at that temperature. Freezing has many remarkable effects on colloidal solutions or on gels. It often coagulates the former and sets up strains in the latter which persist as doubly refractive zones. It is important to remember that the effects are those of drying and not simply of cold.

This work has shown that cold is a powerful agent for the analysis of physiological function. A phosphorous carbohydrate cycle is widely characteristic of living matter as widespread as the oxygen-transferring chain (it is usual now to state it in terms of hydrogen) of catalysts based upon the pyrrole ring. It exists in the muscles of animals, in yeast, in simple single-celled animals—the protozoa. Living matter, in spite of its diversity of form, has a curious chemical unity.

The other remark which the influence of freezing upon muscle suggests is that death is an extraordinarily difficult thing to define. As a mass phenomenon it is easily recognized. Certain functions cease, *e.g.*, consciousness, capacity for movement. But the death of organs is different. It is possible, as we have seen, to destroy parts of the chemical machine, leaving the rest capable of working for a time, at any rate. The nearest I can come to a definition of death is the loss of that function characteristic of the organ, if indeed there be such a singularity.

Movement or the capacity to contract when stimulated is the abiding characteristic of living muscle, and the final death of a muscle is the chemical and physical event known as *rigor mortis*. But consider the curious case of the brain: consciousness is its peculiar function, but when that has gone much remains; it can, for example, respond to a narcotic and distinguish between a true narcotic such as chloroform, or chloral and an ordinary protoplasmic poison. Obviously its catalytic systems are intact and remain intact for many hours.

Fig. 5 is a curve from Quastel and Wheatley's paper in the Proceedings of the Royal Society. It exhibits the rate of uptake of oxygen by the brain of a guinea-pig killed by bleeding. The brain has been removed, chopped up, and mixed with a dilute solution of salt. The "normal" curve is the curve of the chopped-up brain without anæsthetic, the A.I.B. curve that of brain when a dose of an anæsthetic sufficient to put a guinea-pig to sleep has been added to the suspension. The

normal curve falls as the store of carbohydrate is burnt up. Feeding with fresh fuel, glucose, causes a rise *in the uptake of oxygen.* Observe that the rate of oxidation is lowered by the anæsthetic. But the *action of a true anæsthetic is on one part only of the*

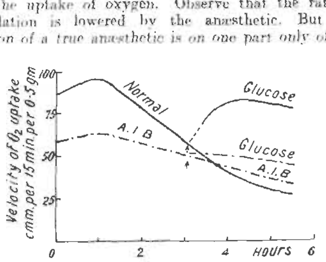


Fig. 5

catalytic machinery: carbohydrate is burnt in brain as in muscle, as lactic acid, and it is the change lactic acid $\rightarrow CO_2 + H_2O$ which alone is inhibited. A narcotic simply deprives the brain of the power of securing energy from a certain type of oxidation, and as the narcotic itself is broken down or eliminated the effect wears off—there is no irreversible damage.

Tissue "survival" is indeed a curious and fruitful field of study: the staff of the Low Temperature Research Station are happy in the opportunity they *enjoy of exploring it.*

The influence of temperature upon the rate of *respiration of an apple is interesting.* Reverting to Fig. 1, we will concern ourselves with the survival or *storage period* B C D. Fig. 6 *shows curves of rate of* output of carbon dioxide at 2°, 10°, and 25° C. It is *taken from* Kidd and West's *paper in Proceedings* B of the Royal Society. You will notice at once that all *the curves have the same form, but there is more than* that. If the scale of the time axis is adjusted the three

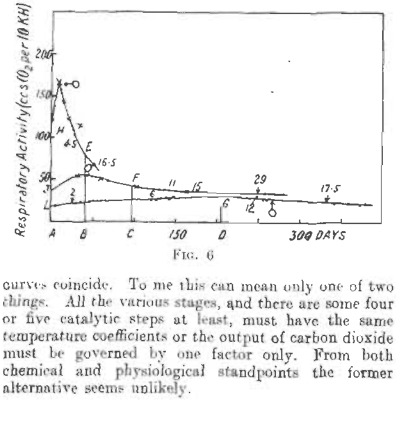


Fig. 6

curves coincide. To me this can mean only one of two *things.* *All the* various stages, and there are some four or five catalytic steps at least, must have the same temperature coefficients or the output of carbon dioxide must be governed by one factor only. From both chemical and physiological standpoints the former alternative seems unlikely.

The one governing factor may be a chemical step down like the final one in muscle: lactic acid $\rightarrow CO_2 + H_2O$. That again is unlikely because the rate would depend upon the concentration of the substrate and that on the *working of other parts of the catalytic machine.* It looks as though there were, in an apple, some governor *controlling the rate of escape of carbon dioxide.* In yeast the rate of working depends upon the supply of *phosphate, all of which in normal activity must pass* through the cycle as hexose phosphate every five or six *minutes. Nothing, so far as I know, is known of the* phosphates in the apple. Another and obvious sugges*tion is the rate of diffusion of oxygen—not of carbonic* acid because it diffuses so much more rapidly. Another *guess which has biological facts in its support is the* semi-permeability of the skin to the respiratory gases. *At any rate the temperature curves point strongly to one* such factor governing the rate of chemical change.

The two parts B C and C D are different periods in the apple's history. Taking Bramley's Seedlings (and we have to fix upon one variety since varietal influence is not yet known sufficiently to be neglected), over B C

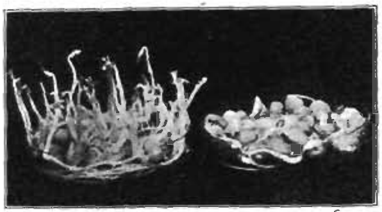


Fig. 7

that variety is peculiarly susceptible to the injury of internal breakdown when subjected to cold. From C to D it is however only slightly susceptible to internal breakdown but increasingly liable to attack by fungi. The two types of disease have also an interesting and commercially important relation to temperature, which might be shown on a diagram in which the ordinates give percentage wastage or mean duration of storage life. The two curves for fungal rots and internal breakdown cross at about 3° C., and that is then the optimum temperature of storage of the particular variety, Bramley's Seedling. Injury to the skin as by cutting an apple in half is followed by increased output of carbon dioxide—the botanist dismisses the fact as "shock."

This lecture leaves many gaps and is no more than a collection of instances: I have omitted altogether gas storage of meat and fruit. I must mention however that apples give off vapours or emanations in minute quantity, which are profoundly poisonous to other fruit. One part in about fifty thousand seems to be a toxic dose. The result of attempting to grow potatoes in air which has passed over an apple can be seen in Fig. 7. Valiant attempts are being made to isolate and identify the substance or substances responsible

so far without success owing to the small quantity involved. Whether the phenomenon will prove to be of biological interest we do not yet know, but it has a commercial interest. The emanation tends to hurry up the rate of ripening of young apples, whereby a colony of apples, as we have long known, tends to ripen at about the same time. This would seem to be a purely artificial phenomenon, of no possible use to the apple: but that kind of forecast is apt to be upset by research!

MODERN TRENDS IN THE BRITISH BY-PRODUCT COKING INDUSTRY

By G. E. FOXWELL, D.Sc., F.Inst.P., F.Inst.F.

The British by-product coking industry to-day finds itself in circumstances of peculiar difficulty. We are perhaps too ready to speak of the difficulties or successes of an industry and to neglect those of the individuals composing the personnel of that industry. Industry primarily exists for the purpose of enabling those engaged in it to exist also. In speaking of the coking industry, therefore, the writer desires to make it clear that he is considering not only the technical aspect of plant and processes but also the human element, without which those inanimate objects would be worthless.

To understand some of the factors of the modern problem of the coking industry in this country, it is necessary to remember its earlier history. Coke ovens were developed for two reasons. In the first place the supply of wood for charcoal making was becoming scarce so that the iron makers were likely to be in difficulty regarding their supplies of carbon; this need resulted in the manufacture of coke by the producers of the raw material just as charcoal was previously manufactured by the woodmen. Naturally, the technical methods used were the same in the two cases. When it had been established that coke could be made from coal and that the product could be sold for iron making, the colliery owners discovered that here was a way of converting their slack coal—virtually a waste product—into a source of profit. The second factor did not come into operation all at once, as only lump coal could be used in the Meiler Heap. It was not until the bee-hive oven was devised that slack coal could be used. Here then we have two reasons why coke oven development was originally settled in the hands of the colliery industry and why it remained in the hands of that industry for so many years. Coke-making as a technical art suffered because of these circumstances in its development. The coke ovens were of no more account than any other piece of surface plant, and like the washery, the loading plant etc. were under the care of the surface foreman and other colliery officials who had no special interest in developing this part of the plant. Another draw-back was that although the coke ovens were highly remunerative, they were definitely only one part of a much larger and financially more valuable whole. There was not therefore the incentive to active development which spurs on an industry that has to stand wholly upon its own feet. It is not surprising therefore that the early technical advances in by-product coking came from outside inventors rather than from the workers within the industry; these inventors subsequently became the coke oven construction companies. As time passed the erection of by-product coke ovens became a most important industrial undertaking, employing the undivided activity of a number of firms; the development and construction of coke ovens is still in the hands of these firms or of others that have sprung from them.

The coke oven industry, by which is understood those employed therein, is in a difficult position. Policy is controlled either by the iron and steel industry who purchase the coke or the collieries who own the ovens and operate them as a means of enhancing the value of their slack. Technical development in the widest sense of the term, therefore, is more or less impelled from without, and the coke oven operators are not free agents in technical development.

Up to the end of the war the industry was uniformly prosperous. Several orders for new coke ovens were placed every year and constructional firms shared in the general prosperity. The coke oven manager improved in status; the colliery foreman no longer controlled the ovens, and even the colliery manager in many instances had his finger removed from the coke oven pie. It was becoming recognized that the manager of the coke ovens should be a chemist or an engineer with definite coke oven training. The Coke Oven Managers' Association, which was formed about this period, contributed in no small measure to this improved state of affairs. In the past collieries had been, in many instances, jealous of their neighbours knowing what was being done at their works; those were the days of industrial secrecy, and acquaintanceships between managers of coking plants were frowned upon and in some instances forbidden; naturally the technical education of coke oven staffs developed slowly. By the end of the war approximately 130 by-product coking plants were in operation, each with its staff of workmen, foremen, chemists, and each having its manager and in many instances its under-manager. Most of these plants were situated at collieries but some metallurgists had early seen the advantage of situating the coke ovens at the iron and steel works. Where this was done however the iron works possessed its own collieries, as at Ebbw Vale, Cargo Fleet, etc. Constructional firms had vied with each other to improve their ovens and by-product plants. Technically the industry emerged from the experimental stage, this being achieved by perfection of the heating system, but without any material alteration of the dimensions of the oven. Economically all had been plain sailing; a highly satisfactory condition of expansion had been set up.

Then, following the close of the war, all was changed. The by-product coking industry passed with startling rapidity from being a standardized industry operating under well-defined conditions, to one in which there was no stable ground. The sulphate of ammonia market—the principal by-product from a financial point of view—was so affected by the commercial exploitation of synthetic ammonia that the price dropped to unremunerative levels. To-day ovens are more concerned with finding means for throwing their ammonia away than for selling it. The price of coking slack rose higher in relation to the price of coke than it had done formerly. Wages increased; costs had to be decreased and some

new source of income discovered. Labour costs were selected as the key item wherein it was imperative that there should be a reduction. The coke oven construction companies were bidden to devise means for reducing costs as a condition of obtaining orders. It was a time of "mechanization gone mad"; machinery was considered as the solution to every problem of coke oven costs; the number of operations was to be decreased, following approved "industrial efficiency" practice, and *to do this the size of the units was increased. The result* of this policy was the inception of the modern large-sized coke oven, which *is fitted with the most elaborate* machinery for handling the much greater weight of coke and in order to reduce the number of men employed to a minimum. The scarcity of men during the war, and the frequent labour disputes in the mining and other industries induced this attitude to become very widespread—an attitude which in its world-wide aspects and effects *may well be responsible for much of our troubles,* now that there is no scarcity of labour.

The size of the coke oven chamber was increased so *that it held double the amount of coal per charge,* and in consequence the wall area was considerably increased. At the same time a demand arose, more on the Continent than in England, for an improvement in the quality of the coke. In order to produce this improvement, one of the essentials was uniformity of heating. New technical problems were introduced by *the necessity for heating with greater uniformity* this larger wall area, and in order to solve these problems, new designs were adopted, which further increased the cost of the construction. The net result of all these efforts is that the quality of the coke produced in the modern oven has been much improved, but the capital cost per ton of coal carbonized has been immensely *increased. To build small plants on modern lines is now* quite uneconomic, whilst to build them on the older style may cause the cost of coke-making to be too high *because of the higher labour charges.* The trend of development has inevitably made the small installation obsolete, and existing small installations can only continue to exist because (1) there are not enough large modern ones to produce all the coke required and (2) the small plants having in most instances been built a very long time ago the capital charges have been virtually extinguished.

As the older plants become so old that it will no longer pay to repair them, it is clear that they cannot be rebuilt unless some change is made in present practice. The by-product coking industry is now definitely contracting, not because less coke will necessarily be required, but because that coke will be made in fewer plants. It is quite likely that the 130 plants we have mentioned previously may be reduced in the course of a few years to something less than 50. This tendency is *highly deplorable* from the point of view of the personnel of the industry. The big new installations require no more men and no more staff *per installation* than did the older small ones. Opportunity of employment for existing personnel is becoming restricted and there will be a shortage of men adequately trained in the, perhaps distant, future. Opportunity for advancement, for juniors is becoming less since fewer managers are *required.* Those employed in the industry take a *gloomy view of their prospects, particularly, of course,* the juniors, and there will probably be difficulty in securing adequately trained recruits. This state of affairs may not be vastly different from that prevailing in some other industries where rationalization has put its hand, but is somewhat complicated here by the fact that the by-product coking industry is so dependent on the iron and steel industry that it cannot expand *as a blast furnace coke-producing industry* of its own volition.

There are signs, moreover, that the iron and steel industry may have even more to do with the control of the coke ovens in the future than in the past. When ammonia failed as a by-product, the only one that could obviously be put in its place was gas. Gas was supplied to one or two gasworks before the war, and in the early years of the last decade, the coking industry canvassed the gas market assiduously; the gas market has closely approached saturation to-day, but unless an additional source of income is found it is not economic to build even the large modern plants with their low operating costs. One solution which has been put forward by the present writer is the development of subsidiary industries. Just as the colliery industry developed the coking industry—a purely chemical undertaking—to utilize its coking slack, so the coking industry might develop subsidiary gas-using industries which would dispose of its surplus gas. There must be many fuel-using undertakings which could operate very profitably on gas at, say, 8d. per thousand cubic feet, a price which would be cheap to those industries, but highly satisfactory to the coke ovens. The solution which appears most likely to prevail to judge from present indications is that more and more coking plants will be constructed at the steel works. None of the recent large installations built or building is at a colliery, with the sole exception of a few ovens at Manvers Main. Partington, Ford's (Dagenham), the Gas Light & Coke Co. (Beckton), Lysaght's (Scunthorpe), and now Stewarts & Lloyds (Corby) are all recent instances. A colliery that is to erect one of the large modern plants must have a large output of coking slack; such an output, indeed, can only be produced from a number of collieries acting in unison. It was hoped by those interested in by-product coking that neighbouring collieries would pool their resources to erect a combined coking plant, but the British colliery proprietor proved to be too strongly individualistic to permit of such arrangements being made. Whether the compulsory amalgamations now under discussion will assist matters remains to be seen. At the present time, however, the only colliery companies that can hope to erect a modern coking plant are those owning a number of collieries situated within reasonable distance of each other. The iron and steel companies, however, do not suffer from this disability, and having a ready market in their own works for the surplus coke oven gas can and do erect the large installations that in spite of their high cost produce the cheapest and the best coke. The position at the moment, therefore, is that the coke-making industry is leaving the control of the collieries and is passing into the control of the iron-works. It is true that

at the present time coke-making is hardly remunerative, but that must obviously be a passing phase, and the collieries can hardly view with equanimity the loss of an industry which has proved so lucrative in the past.

The search for new by-products to take the place of ammonia which has so deteriorated in value, as has been indicated previously, has only discovered gas for town's purposes. The South Yorkshire gas grid is an endeavour to use the gas industrially, but according to the Area Gas Committee has only limited application. This market is now satisfied by existing contracts under present conditions. A determined attempt was made to cheapen the cost of manufacturing sulphate of ammonia by making use of the H_2S contained in the gas to provide the sulphuric acid, but the experience of those who developed this process has not been such as to encourage other experimenters; economic reasons have indeed rendered the process—and probably all similar processes—unworkable for the present. Suggestions have been made to use the CO_2 in the gas to convert the ammonia into carbonate, and a plant has been designed for the purpose. When all is done, however, the fact remains that by-product coking is very far from being the remunerative proposition it once was and that no by-product of general applicability has yet been found to take the place of those which have decreased in value.

The collieries are thus faced with the problem of what to do with their slack coal; only the largest colliery companies can solve that problem by converting it into blast furnace coke, and even they must have some misgivings that the iron-works will in the near future insist in owning their own coking plants. The present personnel of the coking industry is facing the problem of the future with similar misgiving; it is a serious problem for keen men on the sunny side of middle-age who have given their whole energies to working in one particular industry to discover, overnight as it were, that that industry has ceased to provide them with reasonable chance of preferment and may instead discard them altogether in the near future. The problem of the by-product coking industry in the writer's opinion is not strictly a problem in by-product coking. It is a problem of how best to dispose of slack coal—coking and non-coking coal alike—and of how to utilize the staffs of the present coking plants, both to their own satisfaction and to the advantage of the colliery industry which they have served for so long.

The solution of that problem appears to lie in a wider outlook for the coke oven technologist and for the colliery owner alike. Their outlook must no longer be bounded by the bunker, the rows of ascension pipes, the scrubbers and the benzol house roof that now constitutes the horizon of the by-product coke oven plant. Coke ovens can be made to produce solid smokeless fuel for domestic purposes and to those who happen to be in possession of the fullest knowledge of what can be done in this way there is here a highly attractive field. A definite solution of this problem is already available, and coke equal to the best low-temperature coke can be produced in coke ovens. The production of oil from coal in order to supplant imported oil is another highly attractive proposition worth while investigating. The oil so produced could be mixed with coal in the form of oil-coal suspensions, and sold for burning purposes in place of oil alone. Briquetting has been known for a long time, but who would be bold enough to say that finality has been reached? Hydrogenation may well be developed by research now in progress until it becomes attractive. There are many other possibilities open, doubtless, which inquiry would discover. This needs a wider outlook than has yet shown itself in the coke oven industry—men and masters alike. It will necessitate the employment of skilled investigators, of men of vision and initiative. The recent appointment of the Coal Utilization Council suggests that the mining industry is achieving this wider outlook, and it may well be that the by-product coking industry, in so far as it concerns the colliery side of that industry, may be metamorphosed from the drab chrysalis it now presents into a brilliant butterfly—the Coal Utilization Industry.

INDUSTRIAL HYDROGENATION*

By J. B. PHILLIPS, M.Sc., Ph.D.

The application of catalysis to chemical processes is one of the most fruitful fields of investigation at the present time, and the treatment of organic substances with hydrogen, to develop desirable properties in them, has been one of the most useful applications. Hydrogenation is carried out in industry to-day by methods based essentially on the simple procedures used many years ago by Sabatier, Willstätter, Ipatief, and others for hydrogenation in either the gaseous or liquid phase. The earliest application of these principles in the treatment of organic substances on a commercial scale was made by Normann, in 1903, in a patent for the hydrogenation of liquid fats.

The process of hydrogenation lends itself to very careful control, and the nature of the products can be varied to suit the demand. The most important factors in the control of the process are: *Pressure.*—High pressure has been of great advantage, on account of the volume contraction in the reaction, and also in influencing the course of the reaction in certain cases. *Temperature.*—This is important since the products may undergo dissociation or polymerization at high temperatnres, whilst the velocity of the reaction is usually increased by raising the temperature. *Catalysis.*—The method of preparation of the catalyst has a great influence on its activity, those prepared at low temperatures often showing the greatest activity. The amount of surface exposed, particle size, and crystal form, are very important, rather than the actual weight of catalyst used. *Treatment of raw materials.*—In most hydrogenation processes very sensitive catalysts are used, and poisons must be absent from the raw materials. Free fatty acids are also undesirable in the hydrogenation of fatty oils. *Time for reaction.*—Feed must be regulated to allow sufficient time for reaction in continuous processes.

The hydrogen may be manufactured by any of the following methods: (1) electrolysis of water, or as a

* From a lecture given before the Montreal Section on October 26, 1932.

by-product in the electrolysis of brine for caustic and chlorine: (2) iron sponge and steam, or iron and liquid water under very high pressure: (3) liquefaction of other constituents of coke oven gas or water-gas, leaving the hydrogen gas: (4) coke and steam. Two other processes which have been developed recently will be mentioned later.

Hydrogenation of Fatty Oils

The oils used are marine animal oils such as body, liver, and blubber oils, or vegetable oils such as cotton-seed or soya bean oils. The fish oils are generally impure and high in free fatty acids and yield solid fats used mainly in soap manufacture, whilst the vegetable oils are comparatively pure and neutral and give solid edible fats of high purity.

The catalysts generally used are nickel and copper. Platinum and palladium are very effective, but are too costly for general use. Iron is also useful but acts very slowly. Nickel is very reactive but easily poisoned, whilst copper is not so reactive but more resistant to poisons: mixtures of nickel and copper have been used with good results. The nickel catalyst can be prepared by reduction of nickel sulphate, hydroxide, nitrate, formate, or carbonyl, on a carrier, or with a bulking agent such as kieselguhr, pumice, or clay. The raw oil must be deodorized, neutralized, and freed of stearin and protein material before hydrogenation, and the hydrogen used must be free from poisons.

The reaction is carried out in welded steel vessels, with suitable means of agitation, and steam and water coils to control the temperature. Pressure of about 15—25 lb. per sq. in. is employed and the temperature is kept at about 175° C. to avoid decomposition of the fats. The reaction product is filtered in a press, and the catalyst recovered for use again. The filtered oil is allowed to cool and solidify, the reaction, which is essentially a batch process, being carried on to the stage of hydrogenation desired.

The hardening of fatty oils represented for many years the main achievement in industrial hydrogenation but more recently advances have been made in the technology of catalysis.

In Germany, low-grade lignites and brown coal are used as sources of hydrogen and other products, and the producer and water gas obtained from them are carefully purified and mixed in proper proportions for the synthesis of ammonia. The tar removed in the purification is distilled, yielding oils and pitch, whilst sulphur compounds are removed from the gases by activated carbon, the free sulphur being recovered and sold in the form of brimstone.

Carbon dioxide from the impure gases, together with gypsum, ammonia, and nitric acid from the oxidation of ammonia, is used on a large scale in the making of urea, ammonium sulphate, and calcium nitrate, all valuable fertilizers, and purified water gas is used in the synthesis of methanol, zinc and copper oxides and chromates, being employed as catalysts. More recently the synthesis of higher alcohols from carbon monoxide and hydrogen under high pressures has been accomplished by P. K. Frolich and co-workers.

Various attempts were made to apply hydrogenation to such materials as coal, lignite, peat, tar, etc., but this problem offered great difficulties on account of the impurity of the materials, and the sensitiveness of the catalysts. The Bergius process was finally developed (1913) in which pressures of 6000—7000 lb. and temperatures between 400°—500° C. were employed. The treatment consisted of cracking and hydrogenation. No catalysts were used, but small percentages of iron oxide were added to remove sulphur. The products contained appreciable percentages of undesirable cresolic bodies, and the process did not become commercially successful. The process was taken over by the I. G. Farbenindustrie and a very intensive investigation was begun to find catalysts which would be suitable for use with such impure materials, and to work out a process for producing hydrocarbon products free from phenolic and cresolic bodies. These efforts were successful, and it was found possible to produce gasoline, gas oil, kerosene, and lubricating oils, from lignite, brown coal, and tars. This process, in conjunction with the low-temperature carbonization of coal, is a very important factor in the utilization of low-grade fuel resources in Germany.

Investigations carried out at the Greenwich Station show that by treatment of non-coking British coals with very small proportions of hydrogen under pressure, the material is converted into a coking coal with very desirable properties, and by further hydrogenation the coal can be liquified. This process may be of great value at some future time.

Recent catalytic processes for treating such substances as benzene and its derivatives to give saturated cyclo-derivatives such as cyclohexane and cyclohexanol, as well as reduction products such as tetralin and aniline, are examples of newer uses of hydrogen in industry.

The most interesting and remarkable development in the field of hydrogenation as far as Canada and the United States are concerned, has been in the petroleum industry. Considerable work has been done as a result of which it is now possible to treat high-asphaltic high-sulphur crude oils and refinery residues with hydrogen under proper conditions of temperature and pressure to yield only white distillate products if desired. The reactions are carried out at 3000 lb. pressure, and at temperatures about 500° C. After cooling, the liquid products may be given a further finishing treatment, or if desired may be subjected to cracking in the vapour phase. This process is already in actual operation to a limited extent for producing gasolines, gas oils and refined burning oils, all of which are characterized by their low sulphur content and freedom from undesirable decomposition and polymerization products. Gasolines of high anti-knock rating can be produced if desired. In addition, lubricating oils of premium quality are produced, and these have been found to have very desirable properties as regards flash, residual carbon, gravity, and viscosity-temperature relationships. The process is very flexible, and any or all of the above products can be produced in the same plant by changing the operating conditions. The process is characterized by the absence of formation of tar and coke, elimination of sulphnr, resistance of the catalysts

to sulphur and other impurities in the feed, and the high pressures and temperatures at which the reactions are carried out. This most recent development of hydrogenation will probably lead to fundamental changes in the methods of treating petroleum materials in the future. It is also possible that a similar process of hydrogenation with cracking will be applied to convert coal tar into materials of higher value such as benzene, motor fuel, and toluene.

DEAR LITTLE BUTTERCUP

AN ARCADIAN GILBERTIAN RHAPSODY

The year may well begin with Yellow, the earliest colour to appear. Long ago, as far back as 1878, in distinguished company, the anxious question was posed: "Who is poor little Buttercup that she should expect his glance to fall on one so lonely? And yet if he knew—if he only knew!" Who was that He who so neglected She? Surely a chemist, to judge from what we take to be a description of himself in the context:

"I wore clean collars and a brand-new suit
For the pass examination at the Institute."

So great is the call of the laboratory stool, the botanist has long ceased to care for the flowers of the field, knowing scarcely a name. The Willstätters and Robinsons soar into the empyrean of fierce Cardinal Scarlet and Tyrian blue blossom, of purple grape and magenta beet: men of their stature delve not into lowly glades where sweet little buttercup and puckish primrose "waxen in their mirth" of spring-time "wanton green." He of the lion's tooth too has been left to cultivate bitterness by the wayside, majestic though the display may be that he will sometimes make on new soil. A long, glancing yellow stretch, on the new Dover by-pass road, a couple of years since in May, floats as an ineffaceable vision of auriferous colour before us as we write. However portentous the name *Taraxacum* may appear, it seems to be merely perverted Persian. Returning to our anxious maiden: at last her prayer is heard; one is arisen

Who knows little Buttercup, dear little Buttercup,
Sweet little Buttercup, aye.

Prof. Kuhn of Heidelberg has recently disclosed himself as that adventurous "he." He has kissed her, he admits, not once but nigh on 150,000 times and deftly wooed her with methanol and other spirits, to win from her golden chalice four yellows—to wit, *Lutein*, *Flavoxanthin*—a new find, *Taraxanthin*, and *Violaxanthin*, of which *Lutein* preponderates. He proposes the use of xanthophyll, as a generic term, for the hydroxy carotenes generally, out of respect to the memory of Schunck and Tswett, who clearly recognized that so-called xanthophyll was a mixture—reserving for the main component of leaf-yellow and egg-yellow the name *Lutein*, $C_{40}H_{56}O_2$ (m.p. 193°). Through this recognition of identity, that miraculous egg-making machine known as the barndoor or domestic fowl is shown to have taken the wise course of just using the colouring material she finds in her food: "buy grass" is her clear policy. Why she should so mark her output, not even Heaven knows: the sex does many strange things which no man can understand. *Flavoxanthin* is a trihydroxycarotene, $C_{40}H_{56}O_3$, *taraxanthin* and *violaxanthin* are tetrahydroxy-derivatives. It is only meet that an imperial flower with a name of such resounding fury as *Taraxacum dens-leonis* (*officinale* also) should carry the carotenoid with most oxygen: it is well to remember that, when tamed, the plant is *Endive*. Taraxanthin also colours that sweet harbinger of spring, the Coltsfoot (*Tussilago farfara*); *Impatiens noli-me-tangere*, the yellow balsam; and *Leontodon autumnalis*, the yellow hawkbit, a near relation of the lion's tooth. With all these revelations before us, we may now look Nature in the face and say to the flowers that bloom in the spring, tra la, we have taken you under our chemist's wing and know you for what you are—children of the autumnal carrot!

And that's what I mean when I say or I sing
Oh, bother the flowers that bloom in the spring,
Tra la.

Epilogue:

Is it and can it be,
Nature hath this decree,
Nothing poetic in the world shall dwell?
Or that in all her works
Something poetic lurks,
Even in xanthophylls and asphodel?
In truth, 'tis well.

H. E. A.

INDUSTRIAL NOTES FROM EGYPT

There have been sundry modifications to the Customs Tariff recently which are of interest, most of them being made with a view to assisting local industries, though some of them are adopted purely as a means of raising further funds. Thus animal or vegetable oils and fats intended for industrial use will pay 200 milliemes per 100 kilos (about 4s. 1d.) whereas those intended for any other purpose will pay 18s. 5d. per 100 kilos. Aluminium foil not embossed or coloured in any way will pay 6d. per kilo or 10d. per kilo when printed upon or coloured.

Considerable progress has been made with the plants at the Dead Sea for obtaining bromine and potassium salts, and the area now covered by sea-water is approximately 500 acres. The dams total 9½ miles in length and canals stretch for over 3 miles. Bromine is being produced on a large scale and is shipped regularly from Haifa. Investigations showed that at the bottom of the Dead Sea at a depth of 175 ft. the potash and bromine content was about 50% higher than at the surface, and consequently steps have been taken to make use of this deep level water in the plants.

The building of the Gebel Aulia Dam in the Sudan is being much discussed at the present time, and the question has been raised whether or not the contractors should be required to make use solely of cement made in Egypt instead of that made abroad. The technical advisers of the Government in London are of the opinion that the choice of the cement to be used should be left to the contractors, bearing in mind that the industry in Egypt is of comparatively recent introduction,

whereas it has been established elsewhere for a much longer period. The advocates of the locally made cement affirm that the cement made in Egypt is as good as that brought from factories abroad, and one local firm which makes cellular concrete has found that the output of one of the cement factories near Cairo gives better results than cement imported specially. There is no doubt that this plant in particular is quite up-to-date, and the cement that it produces is fully equal to the best that is made in England.

The Department of Commerce and Industry has proposed the setting up of a factory for the making of jute sacks and bags, of which large quantities are used annually for the transport of onions, sugar, grain, etc. all of which have to be imported at present. Experiments made by the Ministry of Agriculture have indicated that the soil in Egypt can produce jute of good quality, and therefore it could be cultivated extensively. In the note put forward by the Department it was estimated that an annual profit of a very large amount would be made once the factory was in full working order.

It has been observed for some time that the soap made by certain local manufacturers or imported from various sources is of very poor quality, even containing matter definitely injurious to its users. Such soaps are sold at a very low price and consequently compete unfairly with those of better quality sold at a reasonable price. The Department of Commerce and Industry has been considering this matter and proposed to introduce legislation bearing on the adulteration of soap, but it has been thought desirable to embody such provisions in a general legislative measure now in process of drafting which deals with adulteration and commercial fraud in general.

The large model factory for the manufacture of all kinds of glass which the Government proposed to build has not yet been erected, and it seems likely that its erection will be postponed for some time still. In the meantime various foreign industrial concerns have sought to put down factories in Egypt, and one Czecho-slovakian firm has asked authority of the Government to erect near Cairo a factory for the manufacture of all kinds of glass, including optical glass. This request has been refused.

One of the Commissions appointed to study the question of unemployment has noticed that students in technical schools who leave from the leather-working sections often cannot obtain employment at the trade they have been taught, and have to take up other occupations. The making of leather goods has made immense strides in Egypt since the war, but there are certain kinds of leather articles (such as ladies' hand-bags for example) which require more than usual skill in execution and which cannot be made by the usual leather workers. Consequently such goods are nearly all imported. The Commission therefore suggests that the Government should set up a small factory for the manufacture of such goods in which the students from the technical schools who have been trained in this work and who are unemployed can be given work under the control and direction of a competent European leather worker. It is proposed that the capital for this installation should be raised by means of shares open for subscription only to holders of diplomas from the technical schools. The suggestion is still under consideration by the appropriate department.

The Council of Ministers is reported to have approved the installation of a factory for the preparation of vegetable oils which will be under the control of the Department of Commerce and Industry. One of the technical officials of the Department is to be sent to Germany for three months to study methods and processes.

The raising by the big oil companies of the prices of benzine (motor spirit) and kerosene has created a good deal of stir in Egypt, and negotiations have been in progress for a long time between representatives of the companies and the Government. Kerosene is far more important in Egypt than it is in the United Kingdom, and it is the only means that the peasant has of cooking his food or heating water for any purpose; consequently a rise in price is a very serious matter for the country generally. Certain industrial concerns which use large amounts of benzine and kerosene are considering the possibility of importing their requirements direct from Rumania, and there has been suggestions also that an Egyptian company should be formed for the purpose of importing and selling benzine and kerosene in Egypt. Benzine is now Pt. 8 per gallon (1s. 8d.) and kerosene about Pt. 3 per gallon (7½d.).

It has been reported from Palestine that a valuable mineral deposit has been discovered between Gaza and Beersheba containing high-grade sulphur ore. It is situated some five miles only from the railway line from Jerusalem to Kantara. Government experts who have visited it, the report says, have estimated that it contains a minimum of 1,000,000 tons of ore. The deposit is covered with a few metres thickness only of overburden, and therefore can be worked by quarrying instead of mining. The commercial importance of this discovery is enhanced by the fact that with the exception of the deep mines in Italy there is no very great sulphur production in Europe.

Mention has been made already in these notes of the electric power station to be erected to utilize the power resulting from the raising of the Assuan Dam. Power will be transmitted to considerable distances if necessary, and much of it will be used for the manufacture of artificial manures, of which it is estimated that the annual production will be in the neighbourhood of 150,000 tons per annum, representing half the present imports from abroad. This will be a most profitable concern for the State. The choice of the site for the factory in which the manure will be made has been difficult, as although suitable land is available not far from Assuan transport charges to the north of Egypt (Cairo is 550 miles from Assuan) will be heavy. It is hoped therefore, that a site may be found further north.

Considerable progress has been made with the Government scheme for the planting of olive trees in the Mariut district west of Alexandria. Thousands of olive trees have been distributed to the inhabitants and the purchase of the crops guaranteed. It only remains to provide for the irrigation of the land so planted, which so far relies

on rain-water. This should not be difficult, as it should be possible to store rain-water in underground tanks and cisterns, as did the ancient Greeks and Romans who exploited Mariut and the oases on a large scale. Some of the Roman cisterns are still in perfect condition. The increase in afforestation of this area will tend to increase the rainfall and so assist the district towards prosperity. The oil obtained from the olives of the kind now being planted is greater in amount than that obtained in Greece and Italy, and the quality is better also.

Interesting discoveries have been made at Mersa Matruh, which lies on the littoral west of Alexandria, and which it is hoped will become a popular resort in the summer months. An old Greek burial chamber was recently unearthed which was beautifully decorated with mural inscriptions and paintings, of which the colours were still fresh and clear. One of the inscriptions, translated, read "Good luck, Archimedes, a pleasant passage to you." Another discovery is an old Roman water catchment which was uncovered by accident some seven miles west of Matruh. An underground gallery was found upwards of 12 ft. high, 4 ft. broad and nearly three-quarters of a mile in length which contained water to a depth of over 3 ft. This was in a perfect state of preservation. The clay supply pipes made by the Romans were so wonderfully preserved that they might have been made this year.

RADIUM IN CANADA.

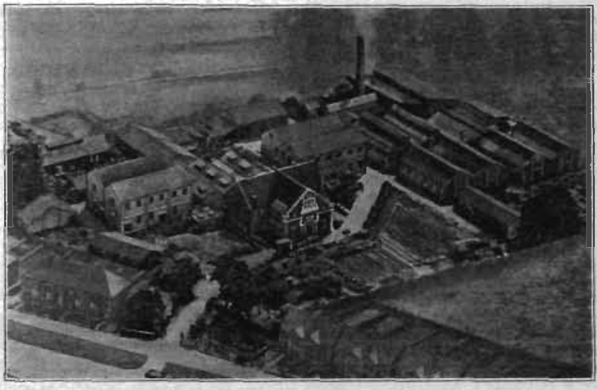
It has been announced that a radium emanation plant is to be erected in the University of Toronto. The apparatus, which will be established in the Physics Building, will prepare radon seeds (or tiny gold tubes containing radium emanations) used in the treatment of some forms of cancer.

JOHNSON & SONS, MANUFACTURING CHEMISTS, LTD.

There are very few chemical manufacturing firms which can lay claim to long histories. It was of all the more interest to us therefore to have visited recently a firm the roots of which are bedded in the dark ages of nearly 200 years ago—dark ages, that is, to the chemical manufacturer, for at that time there was still half a century to go before the Leblanc process came into being, and yet another fifty years before even the birth of Solvay and Caro.

John Johnson established his assaying firm in 1743, with premises in Maiden Lane, London. In 1829 the firm changed its name to Johnson & Sons, and its premises to Basinghall Street, but by 1915 it had outgrown both of these, and so removed itself once more, this time to a large new factory at Hendon, taking the rather longer title by which it is now known. Of recent years the firm's most notable development—and here no pun is intended—has been in connexion with photographic materials, and there are now very few photographers—be they the professional gentlemen who with much patience discipline the congregations at the Society's annual meetings into "takable" formations, or the veriest tyros who, like ourselves, press little triggers on their No. 00 "vest-pocket" cameras and hope for the best—who have not at least heard of the metol, amidol, pyrogallic acid and "Azol" manufactured by Johnson's of Hendon.

In addition to these and many other photographic chemicals the firm manufactures a large number of assaying and pharmaceutical chemicals. Some idea of the factory in which production is carried out can be



Aerial view of the works of Johnson & Sons.

obtained from the aerial photograph which accompanies this article. It would be idle to attempt to give here an account of the many processes which go on inside the factory, for the firm is dealing with hundreds of products, many of them requiring manufacture of only small amounts. What impressed us most forcibly in our tour through the works was the cleanliness and orderliness of production, from the reception of the coal-tar intermediates from which many of the products are derived, through the many chemical reactions, distillations, purifications, evaporations to the ultimate packaging and despatch. Johnson & Sons have an advantage over most manufacturers in having their factory in an area that has not suffered many of the less happy results of industrialization, and inside there is much the same brightness and spaciousness that makes for good and efficient workmanship. Orderliness is of course a prime essential in dealing with so many products and in preparing them for retail trade, and there appeared to be nothing lacking in the smooth arrangements for the storage and despatch of the materials, from carboys and winchesters down to the little brightly-labelled packets with which we were more familiar.

This year sees the large-scale production of hydroquinone at Hendon an accomplished fact, thus completing the family of photographic developers. With regard to metol we can perhaps do something to remove the belief that even now exists in England that this material is all imported from the Continent. Large quantities are manufactured in these works at Hendon, and we were interested to see going on the manufacture, drying, and packing of the white crystals of this material. On the pharmaceutical side, one of the most interesting products was one with the name Arvitin, a silver vitellin made by the reaction of a silver compound with vitellinic acid obtained from egg yolk. This material, which is used in ophthalmic work, has until recently been made, we believe, only in America and its production on a commercial scale in this country by a rather long and intricate process has been made possible only after a great deal of work by the chemists in this Hendon factory.

Johnson & Sons have seen many changes in the practice of photography, and the manufacture of their products has had to change accordingly. It is not so many years since almost every photographer was something of an enthusiast and developed his own negatives and made his own prints, requiring small quantities of material, as much of which was often wasted as was used. Nowadays most photographers are those who take films of half-a-dozen snaps at a time, and deliver them to the local chemist's shop for treatment, the chemist using bulk stocks and making them last until the last grain of usefulness has been removed. Twenty years ago the firm was handling relatively large quantities of gold in the production of toning compounds, but these have been almost completely replaced by less expensive materials. These and many other changes have gone on, and will no doubt continue to go on in the future, but whilst Johnson & Sons make the same endeavours to keep pace with such changes, it will continue to occupy an important place in the industry.

SOCIETY OF CHEMICAL INDUSTRY

OFFICIAL NOTICES

Subscriptions for 1933 are now due and the amount £2 10s. or $12·30 at normal rate of exchange should be sent to 46, Finsbury Square, without delay.

Members whose subscriptions are unpaid are reminded that it is the custom to withhold the JOURNAL temporarily after the first few weeks until the subscription be paid, when back numbers will be made good so long as the supply lasts.

Australasian Subscriptions (New Zealand included) may now be paid by members direct to the Society's account at the Commercial Bank of Australia, 273, George Street, Sydney. Receipts will be issued in due course. This arrangement has been authorized by Council to save members loss on exchange during the period of depressed currency. The bank cannot conduct correspondence on any matters other than the mere receipt of payment.

MEMBERS ELECTED

January 13, 1933

Ball, George Wilfrid, 10, Upper Charlton Street, Fitzroy Square, W.C.1. Managing director, British Film Cleaners, Ltd.

Barsby, Charles Rutland, "Cornwall Court," 1, Cornwall Terrace, Clarence Gate, Regent's Park, N.W.1. Student.

Bradbury, Edward, Cringle Cottage, School's Hill, Cheadle, Cheshire.

Brownsett, Tom, Heath Bank House, Nursery Road, Cheadle Heath, Stockport. Research chemist.

Blakeley, Thomas Hedley, Dept. of Coal Gas and Fuel Industries, The University, Leeds. Research chemist.

Bucknall, Eric Herbert, Red Tiles, 76, Elmfield Avenue, Teddington, Middx. Metallurgist.

Burley, Dr. G. W., M.I.Mech.E., V. J. Technical Institute, Matunga, Bombay, India. Principal of Institute.

Caley, Gilbert Fatkin, c/o "Belton Cottage," Heslington Lane, Fulford, York. Technical chemist and company manager.

Collins, George Ernest, 4, Hawthorn Avenue, Wilmslow, Manchester. Research chemist.

Davies, Drury Norman, c/o Rockhard Resins, Ltd., Browells Lane, Feltham, Middx. Chemist and works manager.

Deacon, William Jarvis, Bradford Corporation Electricity Dept., Sunbridge Road, Bradford. Works chemist.

Denbigh, George James, M.Sc., F.I.C., Brotherton & Co., Ltd., Wakefield. Works manager.

Downs, Edmund (*restoration*), c/o Johnson Matthey & Co., Ltd., 78, Hatton Garden, E.C.1. Metallurgical chemist.

Hooker, Thomas Alfred, 17-19, Cockspur Street, London, S.W.1. Railway industrial agent.

Jones, Leslie, B.Sc., A.I.C., "Bryn Awel," Antons Road, Barnston, Wirral, Cheshire. Chemist.

Kolker, Israel, M.Sc. (Lond.), c/o Eton Road Rural Fabrics, 100 Acres, Uxbridge, Middx. Chemist.

Lennard, William Laurence Arthur, Sussex Wharf, East Greenwich, S.E.10. Chemical manufacturer.

Marks, Sydney, M.Sc., A.I.C., Technical College, Suffolk Street, Birmingham. Lecturer on chemistry.

Mikumo, Jiro, Marumiya Soap Works, Terashima-cho, Mukojima, Tokyo, Japan. Chief chemist.

Moore, H. C., Armour Fertilizer Works, Walton Building, Atlanta Georgia, U.S.A.

Moors, Albert Edward, The Astmoor Tanning Co., Ltd., Runcorn. Tanning.

Oldfield, Charles Albert, Maxwell Plaistowe & Co., Ltd., 22a, College Hill, Cannon Street, E.C.4. Director.

Powers, Harold Edward Charles, B.Sc. Hon. (Lond.), A.I.C., Tate Sugar Refinery, Silvertown, E.16. Analytical chemist.

Rogers, Tracy Percival (*restoration*), Jacob Street Brewery, Bristol. Chairman of W. J. Rogers, Ltd.

Rowe, Walter Tidd, c/o Dept. of Chemistry, Kintore Avenue, Adelaide, South Australia. Director of chemistry.

Rudge, Alfred John, B.Sc., 20, Saltwell View, Gateshead. Chemist.

Rutter, Daisy (Miss), 21, Dulka Road, S.W.11. Research chemist.

St. Johnston, James H. (*restoration*), Whitethorn, Repton, Derbyshire.

Salas, L. E., Bakelite, Ltd., 68, Victoria Street, S.W.1. Chemist.

Stephens, Frank R., F.I.C., 120, Pratt Street, N.W.1. Works chemist.

Stockwell, Henry P. (jnr.), 127, Metcalfe Street, Ottawa, Ont., Canada. Chemical engineer. City of Ottawa Water Purification Plant.

Watson, Henry Adams, William Briggs & Sons, Ltd., Dundee. Chemist.

BIRMINGHAM AND MIDLAND SECTION

Dr. Alexander Fleck, a director of I.C.I. (General Chemicals), Ltd., and executive director of Synthetic Ammonia & Nitrates and Cassel Cyanide Co., read a paper on "A Possible Trend of Scientific Industry" at a meeting of the Birmingham and Midland Section at the University, Birmingham, on Thursday, January 12.

From consideration of different crises in industrial history it is seen, Dr. Fleck said, that so far each crisis was solved by the evolution of methods to meet the difficulty. For example, the industrial difficulties which confronted this country after the Napoleonic Wars were all lost in the great burst of activities which followed the application of mechanical science to industry. A more recent example is the threatened shortage of food material predicted by Sir William Crookes in his address at the end of last century. Scientific chemistry in the fixation of atmospheric nitrogen removed the menace completely.

The position in which we are in this country is undoubtedly one of crisis. Our three million unemployed show no inclination to diminish, and while monetary conditions cannot be held free from blame, and while we would all agree as to the encumbering incubus of international debts, there is the very serious fact that peoples outside of this island show less and less inclination to take materials from us. Examples are: Italy does not want so much coal from us as formerly, India will not take so many cotton goods, Japan is taking steps to make herself independent of our chemicals. The even more serious aspect for us is that there is every indication that, bad as our present position in this respect is, it will get worse as time goes on.

As we show comparatively little evidence of ceasing to find imports of foodstuffs and other agricultural produce necessary, it is clear that our present course of action is leading us to disaster. We require to alter our industrial methods if we are to maintain our population, and I would ask that consideration be given to the question: Can science help us to progress in some more satisfactory method?

What do we do in the industrial field when we find that there is a complicated mess which requires sorting out? *Our method almost invariably is to divide the* problem up into units which are, as far as possible, self-contained and in which the number of varieties is as small as possible, and I suggest that the same reasoning and method should be applied to the world's difficulties. Thus, the unit for our consideration would be those peoples who are prepared to have their currency in common, who are prepared to share the same standard of living in its broadest terms, and who are prepared to have the same political system, including common taxation.

In the course of time, with the growth of an international conscience, I would hope that the unit might be a very large one, but I am afraid that in its early stages the best we could hope for would be an Empire unit. It would seem that the worst position that could arise would be that Britain alone would have to be its own unit and that we would have to erect round it an effective wall, inside which it would be our duty to make ourselves as completely as possible independent of outside supplies. It can be granted that it would be impossible to make ourselves completely independent, but I think it is wise to ask our science if it can help us to be largely self-supporting. The proposition which I would most seriously make is that the trend of our scientific industry should be along the direction of greater independence. How is it to be done?

I think it is generally agreed that there are two basic industries—mining and agriculture: all other industries are merely consequential industries on one or both of these, and my suggestion is that our country cannot get into a satisfactory position until both of these industries have got on to a fonndation for their activities which is at once scientific and capable of being operated by the people of this conntry.

I do not think the mining industry needs our prolonged consideration to-night. It has not perhaps as good an internal organization as we are accustomed to in the chemical industry, but at least this can be said of it, that so far as the materials it has available are concerned the mining industry has never failed to supply the needs of this country. But it has long been recognized and frequently stated, that the agricultural industry of this country is in a deplorable condition, and it is to that industry that the attention of science should, I suggest, be directed to see what we can make of it. I make this suggestion with the full knowledge that in many respects the present agriculturists of this country are far advanced in practical matters beyond their colleagues elsewhere.

During 1931 our total imports were valued at over £800,000,000, of which nearly £450,000,000 were food, drink, tobacco, cotton, or other agricultural produce. It is this material valued £450,000,000, which science should attack and see whether it can be produced with the labour and material resources of our own country.

The £450,000,000 can roughly be divided into two classes:

(*a*) The products of tropical climates, and

(*b*) Products of temperate climates—such as wheat.

PRODUCTS OF TROPICAL CLIMATES

It would appear that there is no fundamental reason why these should not be grown in this country, adjacent to our big power stations. We have got quantities of low-grade heat from the condensers of our turbines, or if that is not adequate steam is available from very efficient combustion of fuel, we have any amount of energy for the necessary light conditions, we have plenty of water, we have cheap fertilizers, and we have plenty of CO_2 for the plants to assimilate. I say therefore, that there ought to be round high efficiency power stations large farms for tropical fruits and produce, and that in these we have the possibility of replacing large quantities of our imports of tropical products.

Large quantities of research work will be necessary to work out the most desirable conditions, but I can see no insuperable difficulty in the method.

A still further possibility may be indicated for agriculture development coupled with the efficient combustion of coal. Is it beyond the range of science to work trees and plants on a twenty-four hour basis by giving them continuous supplies of adequate heat and suitable light? Undoubtedly much research work to overcome many difficulties is required, but is there any fundamental reason why it is impossible? I know that in continuous light, plants which have been experimented on have had their flowering properties upset, but I gather that the plants continued to live. If we made this possible by such plants as the cotton plant, we open a possibility of putting the textile businesses of Lancashire in a position independent of the troubles of American exchanges.

The operation of tropical product factories would of necessity take place in enclosed buildings, and would lead the way in a much-needed direction, namely, the carrying out of agricultural operation under conditions suitable to the temperament and characteristics of our working men.

I am convinced that we will never get the people of this country to return to agricultural life as it is led by agricultural labourers to-day. But reduce the conditions of agricultural work to the conditions ruling inside our technical efficient workshops and factories and we immediately have a population well qualified to develop such schemes.

PRODUCTS OF TEMPERATE CLIMATES

The trend of industry here would depend largely on how far research work on lines indicated above would develop. In discussing these matters with my colleague, Mr. R. M. Winter, I found that he had developed ideas allied to those indicated here on the factorization of wheat growing. *If the rate of growth can be increased as we know it can, can we not multiply it up so that it will be possible to grow wheat in controlled conditions inside specially adapted buildings fitted up with lighting, heating, water, and fertilizer supplies, so that the yields will be regular and of a predetermined quality?* But it is clear that this stage is more difficult than the tropical farm.

THE BUILDING OF FARMS

A more immediate line of development which would assist our position wonld be the building of farms.

At present we build a farm steading, but little effort is made to build and mould to the best form the actual land on which material is to be grown. I would suggest that there is scope for the application of engineering science to farm construction. When we set out to build a factory steps are taken to see that the buildings are adapted to give the best results. From the viewpoint of a scientist much might be done for the more direct application of mechanical science to agricultural industry. Dr. Armstrong in a recent address was obviously thinking along the same lines when he foreshadowed that it would be found advantageous to have farms run not by individuals but by limited companies just as most other industrial undertakings. That would be a big step in the correct direction. It would have two very important influences:

(*a*) It would enable larger amounts of capital to be spent on proper layout and equipment of farms:

(*b*) It would raise the level of labour conditions in agriculture.

This latter is a most important consideration and anything which will further it is worth doing. It is only by doing so that we will ever be able to get our unemployed working in conditions which are tolerable to them in view of their long upbringing in town and not rural conditions.

I would return for a moment to the unit of organization to which I previously referred, and to the hope I expressed that the unit might be extended from Britain to the Empire. If that were possible then a considerable number of difficulties on the mining side would disappear and our position as regards mineral wealth becomes very strong. I would mention first the copper position where the Empire holds in Rhodesia what appears to be the key position for the future.

With regard to gold our position grows more favourable from year to year.

In 1913	we produced	63·65%	of the world gold
,, 1921	,,	,,	69·13%	,,	,,
,, 1925	,,	,,	70·59%	,,	,,
,, 1930	,,	,,	72·52%	,,	,,
,, 1931	,,	,,	73·44%	,,	,,

The figures for 1932 are not yet available but there is no doubt that our position is yet more favourable.

So long as the most wealthy nations of the world adhere to their present policy of a gold standard so long are we likely to maintain a dominant position as suppliers of the material they have chosen as the arbiter of their wealth.

Many criticisms can be made at the possible lines of development which I have foreshadowed, and I am aware of very many difficulties. It may be said that the U.S.A. has already arrived at the stage when it has an effective wall round it, and that country has not yet arrived at a solution of its troubles. My answer is twofold:

(a) That I am suggesting a line of development to meet the conditions in this country, and not in the U.S.A. where circumstances are quite different; and

(b) The conceptions of social duty in the U.S.A. would appear to be less highly developed there than here.

All that is suggested is that the views expressed might be a stage in the further development of the industrial life of our country. Nothing is more certain than that stage would not be a final one, but I am convinced that if we can have an ordered plan of development we will be in a better position to maintain a contented and virile people rather than drifting about with no idea of the industrial goals we are trying to reach.

Mr. H. W. Rowell (chairman), in proposing a vote of thanks to Dr. Fleck, said that with regard to this new idea put forward for the application of scientific energy, it seemed to him it would be a mistake to limit the unit to the British Isles. The main wealth of this country had always been derived from labour, and unless we could manufacture and export there was very little hope of increasing our wealth. Again, to ensure continuity of manufacture it was imperative that we should obtain a very large quantity of primary products from overseas.

Mr. W. A. S. Calder, in seconding, said they were indebted to Dr. Fleck for the courage with which he had dealt with a subject which would appear strange to many because of its novelty. It was quite an interesting vision to picture banana plantations in Birmingham and orange groves in Oldbury.

A discussion followed in which Mr. J. R. Johnson, Mr. T. F. E. Rhead, and others took part. Mr. Johnson's contention was that it would be wasted effort scientifically to produce tropical produce in this country when enormous quantities of such primary food products were being destroyed in the places in which they were grown, because production was there too great and such cultivation was unremunerative.

Mr. Rhead contended that the utilization of waste heat and energy would afford no permanent solution of the problem, and he suggested that much of the trouble in industry, which had led to so much unemployment, was due very largely to increased mechanization.

Another speaker argued that until there was an effective decrease of our industrial population, which could be achieved by emigration, there was very little hope of grappling effectively with the unemployment problem.

Dr. Fleck, in reply, said he realized that his suggestions represented only a small contribution to the solution of a difficult social problem, and to some it might sound very fantastic. Experience had shown that, so far, very little progress could be made in the direction of securing international agreements on these matters, and therefore it seemed to him that the only practical thing was to develop our own country and then trust to other people to co-operate.

BRISTOL SECTION

A meeting of the Bristol Section was held in the University Chemical Department on Thursday, January 12, when Dr. E. F. Armstrong, F.R.S., delivered the Jubilee Memorial Lecture on "Alcohol Through the Ages." The occasion proved very interesting and attracted a record audience for the Section, the number exceeding 200. The chair was occupied by Mr. R. D. Littlefield and a hearty vote of thanks to Dr. Armstrong was proposed by Dr. T. Howard Butler, seconded by Dr. M. W. Travers and carried with acclamation. The publication of the lecture in the JOURNAL will be awaited with interest.

EDINBURGH SECTION

The third joint meeting of the Edinburgh Section with the local section of the Institute of Chemistry for the current session was held on Friday, December 16, in the Pharmaceutical Hall, Edinburgh, when Mr. A. Muir, B.Sc., of the Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen, gave an interesting address on "Chemistry and Soil Problems in U.S.S.R." The lecturer began with a study of the soil as a purely natural phenomenon of the great Russian scientists, and their contributions to agricultural chemistry were shown. The diversity of soils in the high areas was discussed and explained. It was found that the soil type, hence the chemical changes taking place in the soil, were largely dependent on climate. A short account of the principal soil types encountered, together with the chemistry of their development, was given. The importance of soil types in reclamation or amelioration was touched upon. Towards the end of the lecture the changes in agricultural life since the revolution were described, and this led to a most enjoyable talk on Russian life in general.

CHEMICAL ENGINEERING GROUP

A meeting of the Chemical Engineering Group of the Society was held in the rooms of the Chemical Society, Burlington House, London, on Friday, January 13. Mr. J. Arthur Reavell (chairman of the Group) presided, and a paper on "Corrosion Research on Light Metals" was read by Mr. Freeman Horn of the British Aluminium Co.

The author of the paper did not profess to give an account of new work or even work carried out by himself, but he gave in a concise form a general review of the work that had been done concerning corrosion research on light metals and emphasized the important difference between this and the corrosion of light metals. Neither, it might be added, did the author set out to defend any of the various theories that had been advanced to explain the underlying causes of corrosion in light metals. Attention was called to the reported experiments in Germany which had been claimed to open up revolutionary possibilities with light alloys containing lithium, but

so far details are lacking. Patents had also been taken out in Germany for alloys containing lithium which were claimed to be highly resistant to corrosion but reliable test data had not been forthcoming.

Dealing with the problem of suitable testing to ascertain the liability of any particular alloy to corrosion, Mr. Freeman Horn recalled that a few years ago the chief aluminium producers formed an International Propaganda Bureau to study all matters bearing on the development of new uses of aluminium and its alloys and one of the useful works performed by that Bureau had been the correlating of the different corrosion testing methods employed in the laboratories of the various producing companies and research institutions, and the drawing up of a standard corrosion test procedure to be followed by all the aluminium producers. This was recently issued in the form of a Memorandum.

During the course of the paper Mr. Freeman Horn outlined the work done, and the conclusions arrived at by the most important workers in this field of light metal corrosion, such as Bengough, Evans, and Gough in this country, McAdam in America, and others in Germany, and also briefly stated what was being done by way of external coatings to materials either by metallizing, plating, and oxidizing, and also by the application of paints of various kinds, which latter was now being investigated by the British Paint, Colour, and Varnish Research Association.

There was an interesting discussion on the paper, which was opened by Mr. L. Whitby on behalf of Dr. Bengough who himself was giving a lecture on the same subject at the same time at Newcastle. Mr. Whitby criticized what he termed the old-fashioned statement in the paper that a pure metal of uniform physical condition immersed in a chemically pure uniform simple solution will not corrode. Far from there being increasing evidence of this Mr. Whitby claimed that the evidence was the other way. He added the view that it had been fairly well established that corrosion started either at weak points in the air-formed oxide film which existed on the surface of all metals that have been exposed to the air, or else at times of increased adsorption density in the metallic surface which might be caused by crystal corners or edges. In Mr. Whitby's opinion the Mylius thermic and volumetric HCl test should be abandoned. He also commented on the fallacy of using sodium chloride solutions to reproduce the corrosive conditions of sea water because experience had shown that the view at one time held that sodium chloride solution and sea water were identical was a fallacy. Finally, Mr. Whitby claimed that the selenium process of protecting magnesium alloys published by Dr. Bengough and himself was superior to all others.

Mr. S. Robson discussed the use of light alloys in the aircraft industry and pointed out that absolutely pure aluminium and beryllium were not available, at the same time holding the view that the purity of the metal was an important factor in corrosion prevention. Moreover, he asserted that at present we had not sufficient information to know the real significance of some of the commoner impurities in alloys of aluminium and especially when alloyed as duralumin. In the case of copper, experiments were now being carried out which *indicated the extraordinary influence of occluded gases in regard to corrosion. Moreover, whereas in the case of aluminium the protective coating was an oxide film, in the case of zinc and copper the film was basic carbonate or basic sulphate. Finally, Mr. Robson said his experience of any electrolytic coating process, with the view of preventing corrosion, was that there had been an adverse influence upon the tensile strength.*

Mr. C. J. Goodwin expressed regret that in this country we have nothing to compare with the German D.V.L. or Aircraft Research Bureau which had published some extremely interesting reports on corrosion. It was to be hoped that manufacturers here would get together and see that authoritative reports were issued in this country. As regards beryllium, the difficulty was that there was only about 2% of metal in the raw material and therefore the processes involved were very expensive. However, increasing work on this material had resulted in its becoming purer and more ductile and likely to be more useful than was at first thought. Nevertheless, he could not imagine it being very cheap. Experiments which he himself had carried out with copper and ordinary well-water had given results diametrically opposed to those obtained by any other worker but unfortunately he was not permitted to publish the details. He could say, however, that he had found that the rate of flow through the pipes had almost as much influence as the temperature, which was contrary to all accepted notions. The water in this case had to be used hot and it was found to have a very marked corrosive effect upon copper pipes when in motion. Dr. Bengough's process of treatment of magnesium by selenium was about the best available at the moment but it was very expensive and probably too expensive for anything but aircraft. As regards the anodic process, the D.V.L. had carried out some tests which suggested that this produced a result inferior to that to be obtained by the Paralumin process which was now being developed in this country and was the same as the German Jirotka process.

Dr. A. J. V. Underwood spoke on the question of accelerated corrosion tests and mentioned an instance in which an accelerated test had shown a certain result but when the material was used under practical conditions it failed. A slow test made subsequently, revealed the fault. He also maintained that the degree of purity of an alloy was an important factor in corrosion resistance and pointed to the marked difference in this respect between a 98% and a 99% aluminium alloy. At the same time, the nature of the impurity was of great importance. As regards the influence of occluded gases, it had been found that for use in chemical plant there was a very marked difference in the resistance to corrosion between pure electrolytic copper and pure electrolytic copper that had been de-oxidized.

The author's general reply to the discussion was that his paper was a record of work that had been done and that it did not support any of the theories that had been put forward. As to the point raised by Mr. Goodwin concerning the D.V.L. and the absence of any similar work in this country, he suggested that a great deal was being done here which was quite comparable with that in Germany.

Mr. Goodwin said if that was so it was not being published as it was in Germany, and that made all the difference.

The author said the Stationery Office published reports by the Aeronautical Research Committee from time to time and he believed the most useful results obtained were published.

A cordial vote of thanks was passed to the author.

CORRESPONDENCE

HARRISON MEMORIAL PRIZE, 1932

Sir,—I am directed to inform you that at the meeting of the Harrison Memorial Prize Selection Committee held on Friday last, it was unanimously resolved that the Harrison Memorial Prize for 1932 be awarded to Dr. Harry J. Emeléus.

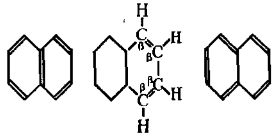
The presentation of the Prize will be made at the Annual General Meeting of the Chemical Society on Thursday, March 30, 1933, at 4 p.m.

I am, Sir, etc.,
S. E. Carr, Secretary,
Selection Committee

Chemical Society,
Burlington House, W.1
Jan. 17, 1933

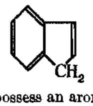
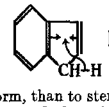
STRUCTURE OF NAPHTHALENE

Sir,—From the general theory developed by Mills and Nixon[1] in connexion with the structures of tetrahydronaphthalene and of hydrindene, it does not appear probable, contrary to the recent statement of Bell,[2] that naphthalene, merely as a result of steric factors, should adopt the configuration I, in which a double bond exists common to the two rings. Owing to the facts that a hydrogen atom is smaller than a carbon atom and that a double bond is shorter than a single bond, a

I  II

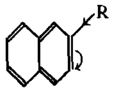
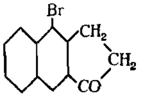
valency angle of type β would tend to be larger than 120° when in an unstrained condition. Consequently phase II of the naphthalene molecule, which possesses a single bond common to the two rings, is sterically in a state of less strain than that possessing the symmetrical configuration.

The symmetrical formulation I does however best explain the ordinary reactions of naphthalene, but its existence in preference to the unsymmetrical form is to be related rather to the strong tendency of both

III   IV

rings to possess an aromatic form, than to steric factors. In this connexion it may be noted that similarly, in the case of indene, the structure III, which possesses a single bond common to the two rings, is sterically less strained than the alternative structure IV. Goss and Ingold[3] however, have plausibly related the remarkable tautomeric mobility of indene to the formation of an aromatic sextet in the five-membered ring, which indicates that this compound must exist to an appreciable extent in the sterically more strained condition represented by formula IV, as a result of "aromatic-nature" requirements.

In the case of naphthalene it is not inconceivable that the less aromatic but sterically less strained unsymmetrical form also arises to some extent. Under certain conditions, with certain reagents, or when the normally reactive positions in the nucleus are blocked, this unsymmetrical phase may be that which leads to reaction. It is thus possible to envisage a mechanism, V, by which an anionoid substituent in the

V   VI

β-position can direct a cationoid reagent into the 3-position. The 3-brominations recorded by Bell[2] in the cases of 1-bromo- and of 1 : 6-dibromo-*p*-toluenesulphon-2-naphthalide may be examples of such substitutions. Other examples are the production of 3-hydroxy-2-naphthalic acid by the action, under strenuous conditions, of carbondioxide on β-naphthol, and the formation,[4] by ring closure of the corresponding acid chloride, of 4-bromo-5 : 6-benzo-indanone-1, VI.

I am, Sir, etc.,
H. W. Thompson

Allgemeines Chemisches Universitäts-Laboratorium,
Göttingen

[1] Journ. Chem. Soc., 1930, 2510.
[2] Journ. Chem. Soc., 1932, 2732.
[3] *Journ. Chem. Soc.*, 1928, 1268.
[4] Mayer and Sieglitz, Ber. chem. Ges., 1922, 55, 1859.

PERSONAL AND OTHER ITEMS

We regret to announce the death on January 13 of Mr. J. L. S. Hatton, Vice-Chancellor of the University of London. Mr. Hatton was the first principal of East London College on its foundation as a day school in 1892. At that time he organized technical and science classes which were attended by a large number of students drawn from the many chemical and engineering works on Thames-side, and developed the higher scientific work of the College until it was admitted in 1907 to London University as a School in the Faculties of Arts, Science, and Engineering. He continued as Principal of the College, and brought it to the high standard which is now acknowledged in science and industry. He had been a member of the Senate of the University since 1903, and from 1922 to 1926 was Dean of the Faculty of Science, whilst he was the author of several works on mathematics, and took a prominent part in many educational activities in East London.

The following have been appointed members of the Safety in Mines Research Board: Dr. C. V. Drysdale, O.B.E., F.R.S.E., Director of Scientific Research at the Admiralty, Mr. F. Edmond, Chief Mining Agent to the

Wigan Coal Corporation, Ltd., and Major H. M. Hudspeth, D.S.O., M.Sc., Chief Mining Engineer to the Board. Prof. C. H. Lees has now completed his extended term of service on the Board, and Prof. Jocelyn Thorpe, C.B.E., F.R.S., whose appointment would normally have ended on December 31, 1932, has accepted a special extension of his term of service for a further two years at the request of the Secretary to the Mines Department.

Lt.-Gen. Sir George Macdonogh has been nominated by the Grand Council of the Federation of British Industries to succeed Sir George Beharrell as President of the Federation for the coming year. On the confirmation of the appointment Sir George Macdonogh will enter into office in April this year. Sir George is connected with a number of industrial concerns and is a member of council of the Royal Institute for International affairs.

Mr. A. G. Byard, one of the original members of the Society, has been appointed Honorary Lecturer in Chemistry to the Bournemouth Natural Science Society.

Dr. Foster Dee Snell has been appointed Consulting Technical Editor of *Soap*. Dr. Snell has written technical articles on detergents and detergency for that publication for some years, and will continue to write for them as in the past.

The Associates Prize of the Coke Oven Managers' Association for the current year has been awarded to Mr. W. M. Hyslop for his paper "The Determination of Phosphorus in Coal and Coke Ash."

We regret to record the death recently of Mr. A. S. Cook, who was associated for more than 46 years with the Newcastle chemical manufacturing firm of Allhusen's which later became the Newcastle Chemical Co., afterwards absorbed in the United Alkali Co., Ltd. At the time of his retirement Mr. Cook was secretary of the United Alkali Co.

We regret to record the death of Prof. Robert Donaldson, the noted pathologist. Prof. Donaldson received his training at the Universities of Edinburgh and Marburg and held appointments at Sheffield, Bristol, and Reading before becoming Sir William Dunn Professor of Pathology in the University of London. He was pathologist to several London hospitals and bacteriologist to the Borough of Kensington.

We regret to record the death on January 13 of Mr. Albert M. Henshaw, who was for more than 30 years director of a colliery concern at Talke, Stoke-on-Trent, and who was a director of the Staffordshire Chemical Co., Tunstall, at the time of his death.

Ostwald Memorial Lecture

The Ostwald Memorial Lecture of the Chemical Society is to be given by Prof. F. G. Donnan on January 27 in the Chemical Lecture Theatre of the University of Liverpool.

Institution of Chemical Engineers

The Annual Corporate Meeting of the Institution is to be held on February 17 at the Hotel Victoria, Northumberland Avenue, London, W.C.1. The meeting will follow the normal procedure of previous years, and after the formal business of the Institution has been transacted the presidential address will be given to be followed after an adjournment for lunch by a paper on "Metallurgy from the Standpoint of the Chemical Engineer," by Mr. L. Singehurst-Ward. The annual dinner will be held in the evening of the same day, the principal speaker being Sir Frederick Gowland Hopkins, P.R.S.

Royal Institution Lectures

Public afternoon lectures to be given at the Royal Institution before Easter will be opened by Prof. M'Lennan with an experimental course dealing with the work on low temperature and low-temperature phenomena, with which work he has been closely associated at the University of Toronto. Lord Rutherford will also give a course of Saturday lectures on the "Direction and production of swift particles" in which he will deal in an experimental way with recent progress at the Cavendish Laboratory.

In a later course of lectures Sir William Bragg is to review the progress made during the last twenty years in the science of crystal analysis by *X*-rays.

University of London Lectures

An advanced course of ten lectures on "The Principles of the Quantum Theory" is to be given by Prof. G. Temple, Ph.D., D.Sc., at King's College, Strand, W.C.2, the fee for the course being £1 11s. 6d. Full particulars can be obtained from the Secretary of the College.

A course of two lectures on "Iodine and the Thyroid Gland" is to be given on January 26 and 27 at St. Thomas's Hospital Medical School, Albert Embankment, S.E.1, by Prof. E. Mellanby, F.R.S., Professor of Pharmacology in the University of Sheffield, admission being free without ticket.

Prof. Max Bergmann, Professor of Chemistry in the Technical College of Dresden, is to give three lectures on "The Chemistry of Proteins" at University College Hospital, University Street, Gower Street, W.C.1, on January 20, 23, and 24. Admission is free, without ticket, and at the first lecture the chair will be taken by Prof. C. R. Harrington, F.R.S., Professor of Pathological Chemistry in the University.

Chemical Company Registrations in 1932

The annual statistical report relating to new companies registered in 1932, issued by Jordan & Sons, Ltd., Chancery Lane, London, states that 528 new chemical companies were registered during the year with total capital of £6,257,989. This figure is much higher than in the previous year, the increase being mainly accounted for by the formation of I.C.I. (Explosives), Ltd., with capital £4,992,900. The chemical group is the second largest on the list.

A New Glucuronic Acid Derivative

In a communication to *Nature*, J. Pryde and R. Tecwyn Williams state that in the course of recent work on glucuronic acid compounds of animal origin two derivatives have been obtained by the methylation of glucurone with silver oxide and methyl iodide. Investigation has shown one of these to be trimethyl glucurone, whilst the second was found to decolorize permanganate and bromine water rapidly, analysis showing it to contain two hydrogen atoms less than trimethyl glucurone. It has been called trimethyl

ucuralone on analogy with the glucals. Its formation ascribed to the mild oxidizing action of silver oxide uring the methylation, further oxidation being no doubt prevented by the subsequent methoxyl groups.

Wholesale Prices in 1932

Figures issued by the Board of Trade show that wholesale prices during 1932 were 2·4% less than in 1931, the index figures for the two years being 85·1 and 87·2 respectively, with 1930 equal to 100. The indexes for industrial materials show a drop from 86·7 to 83·8.

British Standards Institution

The latest publication of the British Standards Institution deals with definitions for fire resistance, incombustibility, and non-inflammability of building materials and structures. These standard definitions should be found very useful, for there can be little doubt that in their absence in the past many suitable and safe materials have been condemned and some unsuitable materials have been permitted. The new standard definitions will be particularly reassuring to the manufacturer, who will now be able to demonstrate that his products fulfil legal requirements. The definitions have been drawn up after a careful examination of existing legal provisions, and methods of test are included. Copies (B.S.S. No. 476—1932) can be obtained from the Institution, 28, Victoria Street, S.W.1: price 2s. 2d., post free.

The Indian Institute of Science

Considerable research work has been done in the Indian Institute of Science at Bangalore during the last year, especially in the Departments of Organic Chemistry and Biochemistry. In the Organic Chemistry Department, Mr. B. H. Iyer is investigating the extraction of oxalic acid from sandal-wood dust and Mr. P. R. Iyer has completed his work on the chemical composition of Mysore "Chrysalis" oil and "Ben" oil. Dr. D. C. Chakravarti and Dr. D. Mazumdar are investigating the colouring constituents of Alkanet root. Research into the manufacture of dye from lac on a large scale is progressing and a method has been worked out for the preparation of laccaic acid. In the Department of Biochemistry, Mr. D. H. Jai Ram has extended his research into the nutritive value of two globulins and Dr. H. S. Sarma has investigated the possibility of using gourds and other indigenous vegetables in the manufacture of pectin. Mr. Narayan Rao is engaged in the standardization of conditions relating to the processing of indigenous food materials. Mr. B. N. Sastri is investigating the possibility of producing in India various enzyme preparations for industrial use. Mr. Ram Krishna Rao is engaged in the determination of conditions most suitable for preserving fruits such as mangos and plantains. Other investigations have indicated the possibility of manufacturing glucose syrup from cashew fruit. Mr. Srinivasa has prepared a variety of polishes, lacquers, and paints, using lac as basic material, and has produced an insulating varnish which has been used satisfactorily by the Mysore State Government for impregnating transformer coils.

COMPANY NEWS

BOOTS PURE DRUG CO., LTD.

It was announced on January 12 that the controlling interest in Boots Pure Drug Co., held by the United Drug Company (of America), a subsidiary of Drug Incorporated, had been sold to a group of British interests. On the following day however it was found necessary to abandon the negotiations for effecting the purchase, following the announcement made by the Chancellor of the Exchequer that he regarded the proposal as conflicting with his request on October 1 last regarding foreign capital issues and issues the proceeds of which would be remitted abroad. The position remains therefore as before, with United Drug Company holding £1,125,000 of the 1,500,000 £1 ordinary shares, which are at present standing at about £7¼.

J. & E. HALL, LTD.

Net profit of this concern, manufacturers of refrigerating machinery etc., for the year ended September 30 was £20,626, including £7096 from profit on sales of investments. Dividend on preference shares absorbs £9000, and with £22,400 dividend on ordinary shares at 4%, £8138 remains to be carried forward.

BAKER PERKINS, LTD.

This noted firm of food, chemical, soap, and laundry machinery manufacturers, of Peterborough, has declared an interim dividend on the ordinary shares of 3%, which is at the same rate as last year.

METALLGESELLSCHAFT A.-G.

The balance-sheet of the company for the year ended September 30, 1932, shows a profit of 45,614 m. which is being carried forward. The company intends to cancel its own ordinary shares to the value of 5,000,000 nominal held in reserve in connexion with the option originally given to subscribers of the 6½% Sterling Loan of £750,000 in 1928, thereby reducing the capital still further to 35,260,000 m. Last year the capital was reduced to two-fifths of the previous total. The profit in respect of the company's sterling loan resulting from the depreciation of sterling is 1,032,908 m. which is to be allotted to the special reserve account which now stands at 3,761,205 m.

CHEMICAL BANK AND TRUST

The financial statement of the Chemical Bank & Trust of New York for the year ended December 31, 1932, shows total assets amounting to $425,241,148. The liabilities side of the statement includes $945,000 dividend payable on January 3, 1933, capital stock $21,000,000, surplus $40,000,000, undivided profits $5,412,501, acceptances outstanding $20,355,778, and deposits $324,457,852.

CONSOLIDATED MINING & SMELTING CO.

The directors of this Canadian company have authorized the distribution of stock dividend on the basis of one new share for every 10 full shares outstanding on record on December 31, 1932.

MARKET REPORT

No price changes have been reported in the markets for chemicals during the past week.

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence), 35, Old Queen Street, London, S.W.1, has received the following inquiries for British goods. British firms may obtain further information by applying to the Department and stating the specific number. *Australia:* Heavy chemicals etc. (34). *Egypt:* Mineral lubricating oils (B.X. 7483); Paint, varnish (No. 25014/33). *Greece:* Iron, steel, pharmaceutical products (51). *Netherland East Indies:* Analytical and pharmaceutical balances (64). *Portugal:* Tinplate, fertilizers (57). *Rumania:* Tinplate, pig iron, zinc and lead, heavy chemicals for the tanning and textile industries (58). *Tunis:* Paraffin and kerosene (61). *United States:* Heavy chromium steel castings and parts for chemical plant (74).

Dyestuffs (Import Regulation) Act, 1920

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during December has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee. The total number of applications received during the month was 603, of which 529 were from merchants or importers. To these should be added 7 cases outstanding on November 30, making a total for the month of 610. These were dealt with as follows: Granted, 593 (of which 584 were dealt with within 7 days of receipt); referred to British makers of similar products, 15 (of which 10 were dealt with within 7 days of receipt); outstanding on December 31, 2. Of the total of 610 applications received, 594, or 97%, were dealt with within 7 days of receipt.

Gas-Fired Conveyor Ovens

An article that will be of considerable interest and use to many manufacturers is contained in the publication No. 226 of "A Thousand and One Uses for Gas," issued by the British Commercial Gas Association. This article deals with use in modern methods of production of gas-fired conveyor ovens in place of the old box type of batch oven. Enamelling, lacquering, and varnishing are now important finishing departments of many industries and a wide range of applications is dealt with in the series of excellent illustrations, whilst the text deals with the principles and practice of stoving such materials as shellac varnishes, nitro-cellulose lacquers, Bakelite, urea formaldehyde and glyptal varnishes, and ordinary enamel.

Pressure-Reducing Valves

James Gordon & Co., Ltd., of Windsor House, Kingsway, W.C.2, have recently issued a new leaflet dealing with their pressure-reducing valves for steam, air, water, and gas. These valves are of very simple construction, can be spring or weight loaded, and are smooth in operation, the absence of packing glands ensuring operation without sticking or chattering. They are made in bronze, high-grade cast iron, or steel as required by pressure and other conditions. The leaflet provides much useful information with regard to construction of the valves, which is further explained by good diagrams.

Price, Stutfield & Co., Ltd.

Price, Stutfield & Co., Ltd., announce that 8 solvent recovery plants operating by the Acticarbone system have been put into operation in this country in the past eight months for recovering solvent naphtha, benzine, acetone, ethyl acetate, etc. Several more plants are in construction at present. Recovery of alcohol from fermentation vats, drying of air for compressors in caisson work, and purification of carbon dioxide are among the latest processes working on a commercial scale. The new address of Price, Stutfield & Co. is 110, Fenchurch Street, London, E.C.3.

PUBLICATIONS RECEIVED

Technische Fortschrittsberichte Fortschritte der Chem. Technologie in Einzeldarstellungen. Edited by Prof. Dr. B. Rassow. Vol. XXIX. Die Industrielle Herstellung von Wasserstoff. By Dr. H. Pincass. Pp. 82. Dresden and Leipzig: T. Steinkopff, 1933. Paper, 6.50 rm.; bound, 7.30 rm.

Stereochemie: Eine Zusammenfassung der Ergebnisse, Grundlagen und Probleme. Edited by K. Freudenberg. No. 5. Pp. 639—798. Leipzig and Wien: F. Deuticke, 1932. 18 m.

Mineral Industry of the British Empire and Foreign Countries. Imperial Institute. Statistical Summary (Production, Imports and Exports), 1929—31. Pp. 398. London: H.M. Stationery Office, 1932. 6s.

Der Chemie-Ingenieur: Ein Handbuch der Physikalischen Arbeitsmethoden in Chemischen und Verwandten Industriebetrieben. Edited by A. Eucken and M. Jakob. With a Preface by F. Haber. Vol. II. Physikalische Kontrolle und Regulierung des Betriebes. 2nd Part. Mengenmessungen im Betriebe. Edited by M. Jakob. Revised by R. Witte and E. Padelt. Pp. ix + 274. Leipzig: Akademische Verlagsges., 1933. Paper, 26 m.; bound, 27.60 m.

Catalytic Oxidation of Organic Compounds in the Vapor Phase. By L. F. Marek and D. A. Hahn, Ph.D. American Chemical Society Monograph Series. Pp. 486. New York: Chemical Catalog Co., 1932. $9.

In Chase of Truth of Alcohol. By Prof. H. E. Armstrong, F.R.S. No. 8. True Temperance Scientific Committee. Pp. 32. 1s.

Chemistry and Technology of Cracking. By A. N. Sachanen, D.Sc., and M. D. Tilicheyev. Translated by A. A. Boehtlingk, D. F. Brown, and K. T. Steik. Pp. 389. New York: Chemical Catalog Co., 1932. $8.

The Journal of the Institute of Metals. Edited by G. Shaw Scott, M.Sc. Vol. XLIX. No. 2, 1932. Pp. 416. London: Institute of Metals, 1932.

Bituminous Emulsions for use in Road Works. By F. Wilkinson and F. J. Forty, B.Sc. Foreword by Prof. R. G. H. Clements. Pp. 395. London: Contractors' Record, Ltd., 1932. 21s.

Cinquième Rapport Annuel, 1931—1932. Fonds National de la Recherche Scientifique. Pp. 215. Bruxelles: Fonds National de la Recherche Scientifique, 1932.